ADVANCED OPTICAL MATERIALS

Supporting Information

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Enhanced Imaging Using Inverse Design of Nanophotonic Scintillators

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Appendix

A.1. Analytical calculation of a structure's PSF

We can interpret $\int d\omega \Gamma_{eff}(\theta, \omega; \mathbf{d})$ as the probability of the light to be emitted at a certain angle θ outside the device. To compute the PSF, one needs to project the emission through the structure according to Snell's law. To calculate this projection, we first focus on a simple case with a single interface and assume that the emitter is located in a material with a refractive index n_1 while the detector is located in a material with a refractive index n_2. We denote the distance of the emitter from the detector by z and the distance of the detector from the interface by d. According to Snell's law, since the light is emitted at angle θ, the light will reach the detector plane at a location given by

$$\tilde{r}(\theta, z) = (z - d) \cdot \tan(\theta) + d \cdot \tan\left(\arcsin\left(\frac{n_1}{n_2}\sin(\theta)\right)\right), \qquad \#(11)$$

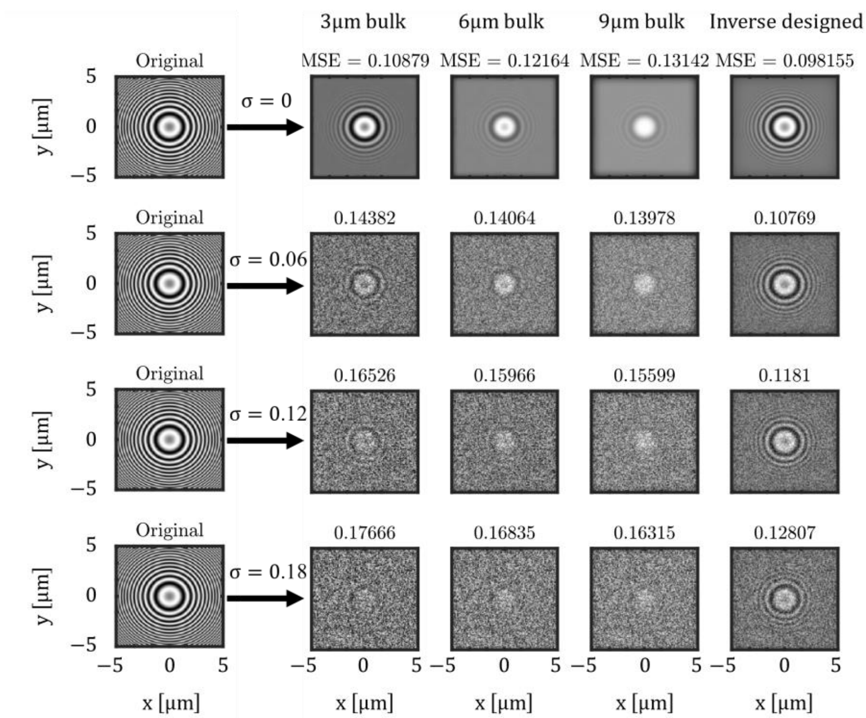
To generalize this relation to any number of layers, one can recursively compute the offset on the r-axis. Finally, the PSF is obtained by collecting the spontaneously emitted light on the detector plane

$$\mathrm{PSF}(r) = \int \frac{\Gamma_{eff}(\theta, \omega, z; \mathbf{d})}{\Gamma_0(\omega)} \delta(\tilde{r}(\theta, z; \mathbf{d}) - r) d\theta dz d\omega, \qquad \#(12)$$

where $\delta(\cdot)$ is the Dirac delta function. This equation can be thought of as accumulating the contribution of all depths and emission angles projected onto r, weighted by the effective emission rate.

A.2. Image detection with an adjusted dynamic range

In this appendix, we demonstrate the effect of the noise on the detection process, for a sensor with adaptive dynamic range. The result presented in Figure 6 and Supplementary Figure 1 are similar, expect the dynamic range of the images is adjusted according to the efficiency of the structures. Due to the lower efficiencies of the bulk structures, their SNR is lower, which further deteriorate the detected images. We observe that the optimized structure achieves the lowest MSE for all noise regimes.



Supplementary Figure 1: The effect of noise on the detected images with adjusted dynamic range. Comparison between the bulks and inverse-designed structures in the presence of additive independent uniform noise. The optimized structure achieves the lowest MSE for all levels of noise.